# WATER CONSERVATION THROUGH IMPROVED MANAGEMENT PRACTICES
## PROJECT 99-HR-03
## FINAL REPORT
## SEPTEMBER 2001

Submitted to the US Fish and Wildlife Service
For the Siskiyou Resource Conservation District
By Jennifer Marx

## ABSTRACT

## WATER CONSERVATION THROUGH IMPROVED MANAGEMENT PRACTICES PROJECT 99-HR-03

With slight exceptions as explained below, all objectives of this project have been met as proposed:

1. Evaluate the efficiency of existing irrigation systems/practices of 10 different growers per year (20 total).
2. Develop a theoretical optimum irrigation frequency using information on soil type, the irrigation system, and historical crop evapotranspiration data. To compare the theoretical irrigation frequency with current grower practices.
3. Identify areas where irrigation system improvements are warranted.
4. Use a "hands on" approach to inform growers when to irrigate specific fields and the correct amount of water to apply.
5. Train growers and Resource Conservation District employees on the use of soil moisture sensors and irrigation scheduling techniques to conserve irrigation water and optimize irrigation efficiency.
6. Develop a brochure on irrigation scheduling using soil moisture sensors to increase the adoption of improved practices, especially designed for growers that are not cooperators in the project.
7. Hold a workshop at the end of the two-year period for cooperators and project managers to share the results and the technology. (In fact, there were two)

All of the above objectives have been met. The brochure has not been developed within the proposed timeline, but the high quality resulting from extra efforts and extra costs incurred by the UC Extension should make up for the delay.

Also, because this is one project that had multiple RCD project coordinators, the training of RCD employees to be able to help growers in the future with this technique is limited to only one employee who was a participant as well. However, John Bennett, the project technician, has forged long-term relationships with the growers. As it is his business to provide the equipment for this project as well as other agricultural products, his continued cooperation with growers is assured.

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## Introduction

The project was designed as a cooperative effort between the Scott River Watershed Council (SRWC) and the University of California Cooperative Extension (UCCE) in an effort to address low flows in the Scott River Watershed. With agriculture using large amounts of water, irrigation management is a logical choice for water savings, which, in turn, may increase stream flows over present levels.

Steve Orloff, UC Extension Crop Specialist, and John Bennett, agricultural business owner and technician, implemented this project with some Siskiyou RCD oversight.

## Description of Study Area

The Scott River is a tributary to the Klamath River in northern California, Siskiyou County. The Scott River watershed total area is 819 square miles or 524,160 acres, 55% private land and 45% public. The area included in this project involves private agricultural land surrounding the reaches in the Scott Valley, estimated in 1991 at 32,443 acres. This area is the low-gradient, alluvial portion of the river between river mile 24 and 56.

## Methods and Materials

### Field Analyses Performed

Over two growing seasons beginning in January 1999, twenty-one (21) local ranchers were selected as grower cooperators for the project using the criteria set out in the project contract and, of course, interest on the part of the participants. The participants' fields included both alfalfa crop fields and irrigated pastures. Soil moisture sensors, modified by John Bennett, Intermountain Seed Company, were installed at three different depths on two sites in each field. Each grower had either one or two fields monitored.

Evaluations were completed including a catch can test to determine distribution uniformity, pressure analysis, and flow measurements to determine output per sprinkler. Sprinkler nozzle size recorded to determine if variation in flow was due to mismatched nozzles. The number leaks and volume of water lost with each leak was quantified. The results of the evaluations were shared with each cooperator via graphs and charts. Using this information, cooperators were informed where they could make improvements in irrigation management. John Bennett and Steve Orloff also advised growers on irrigation scheduling—when irrigations should occur and approximately how much water should be applied per irrigation.

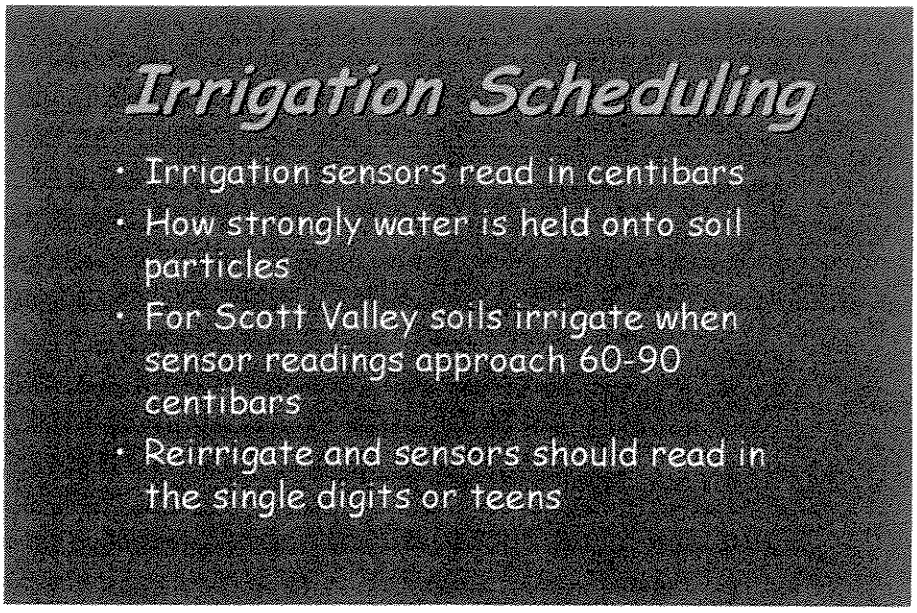
The moisture sensors were read weekly for the growers and they did their own readings a second time per week on an as-needed basis. The data was recorded on a clipboard for each grower and graphed by hand throughout the season so that growers could adjust their irrigation practices during the season as needed. At the conclusion of the growing season, the data was forwarded on to Steve Orloff for analysis. Using the graphs and charts, Steve was advised growers regarding the efficiency of their irrigation systems and where improvements could be made.

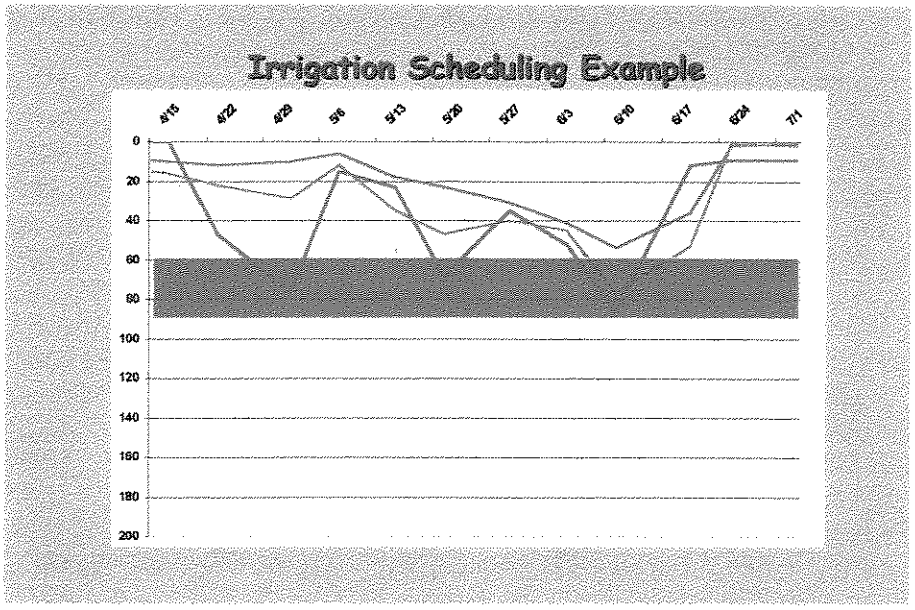
## Results and Discussion

### Dinner and Presentations for Cooperators

At the end of each of the each of the two seasons the RCD sponsored a dinner for the cooperating growers during which Steve Orloff did a Power Point Presentation showing all of the growers' graphed moisture levels (centibars) throughout the growing season and bar charts showing sprinkler nozzle size versus actual flow (uniformity of output along the sprinkler line). Mr. Orloff then made individual recommendations and gave general advice to all.

The following slides are examples of the main points of his presentation for one grower. The example from the individual's ranch is shown with his permission. The evaluation performed at the different ranches was similar, however, recommendations differed depending on the ranch.



## Evaluations Performed

- Output flow per nozzle
- Pressure at each nozzle
- Nozzle size evaluation
- Leak measurements
- Catch-can uniformity tests

## Most Common Most Easily Fixed Sources of Error

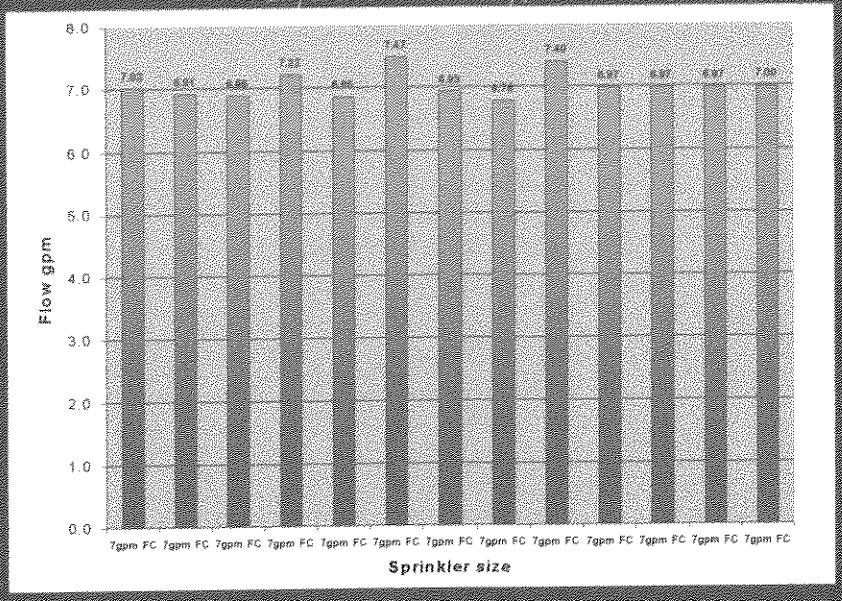
- Mismatched nozzles
- Single and double nozzles on same line
- Leaks
- Improper pressure
- Different set lengths

## Correction for Common Sources of Error

- Determine nozzle output needed to meet peak water needs in summer
- Check nozzle wear with drill bit
- Purchase uniform nozzles for whole system
- Use all single or all double nozzles
- Mark leaks and repair them over winter
- Fix malfunctioning nozzles
- Operate at proper pressure (above 35 psi at last nozzle for wheel lines)
- Use flow-control nozzles where variation >20%

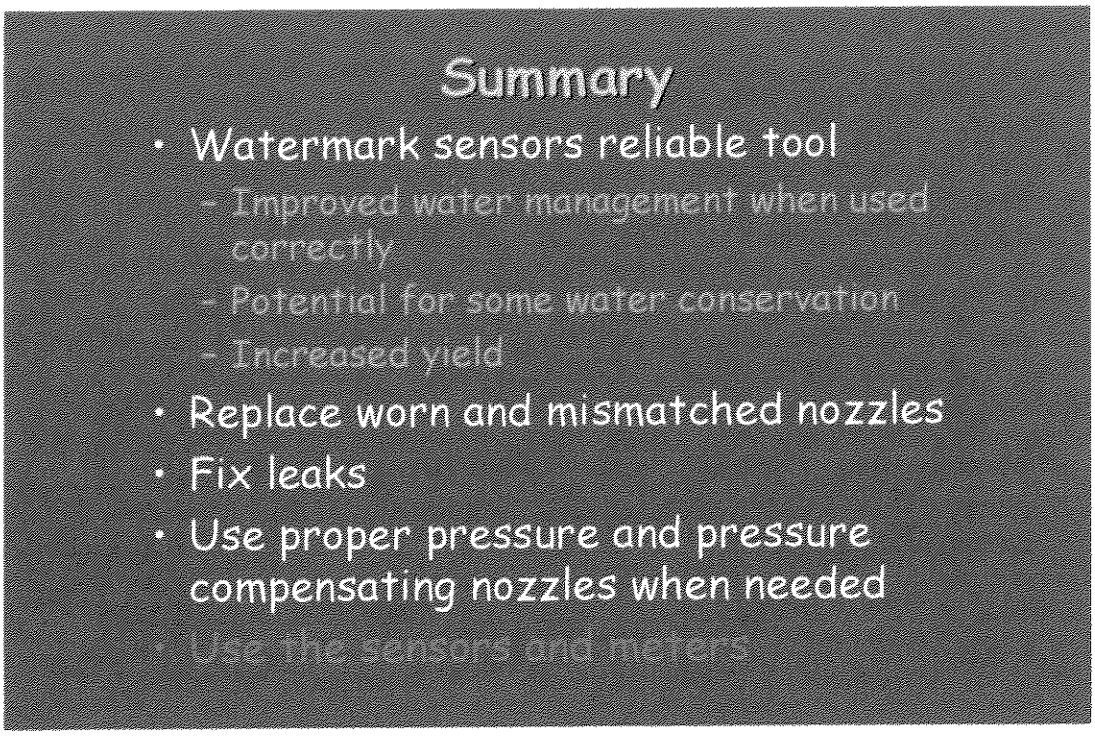
## Sprinker Discharge Rate for Wheel-line

Bryan - Scott Valley, 1999




## *Irrigation System Analysis and Potential Improvements* Bryan Ranch

- 6 leaks
  - (total 25.6 gpm)
- Has flow control nozzles
- Pressure 45 to 48 psi
- Distribution Uniformity = 84% (too good to be true!)
- Recommendations
  - Jim should fix leaks not just change nozzles before Farm Advisor comes out
  - Use sensor to irrigate. May need to irrigate more frequently especially in mid-summer
    - Can be difficult to maintain upper sensor moist in alfalfa/grass




**Public Workshops**
At the annual Growers Seminar sponsored by the Yreka UC Extension on March 10, 2000, Jennifer Marx presented the project background and John Bennett and Steve Orloff presented project information and some of the project results to the audience. Content of Jennifer's presentation is attached as Appendix II. A comprehensive article on the presentation was published in the Siskiyou Daily News, but a copy is unavailable.

Following the dinner for the cooperators in March 2001, the RCD sponsored a dessert for the public to see the results of the project. Steve Orloff presented results and participating cooperators were present to answer questions from the public.

**Extension of Project Technology**
By the end of the 2nd year, there was still enough money left in the budget to assemble one more set of sensors for each cooperator. Seventeen (17) growers requested the additional sensors, which will allow them to equip more of their land. This should increase irrigation efficiencies even more throughout the Scott River watershed.

In summary, this project funded 38 sets of sensors in fields of alfalfa, irrigated pasture, and Timothy grass. Twenty (20) cooperators were trained to use the sensors and graphs to manage their irrigation efficiency. Dozens of nozzles were changed to correct the problem with mismatched nozzles and improve uniformity, and numerous lines were pressure-checked and pressure-compensating nozzles were installed when recommended (when pressure variance is greater than 20%).

**Cooperator Survey Results**
Generally, participants were very enthusiastic about the usefulness of the project for the improvement of their irrigation management. In general, growers that were less satisfied with the project had flood-irrigated fields. It is not possible to perform the in-depth system evaluation with flood irrigation

systems. Uniformity tests are possible with flood irrigation but are not commonly performed and are beyond the scope of this project.

Most growers seemed to benefit from higher irrigation uniformity (i. e., pump less water to achieve the same results), improved crop yield (more efficient use of water) or both. A commonly observed problem was mismatched nozzles, which varied significantly in application rate (in some cases a two-fold difference in output). Purchasing new nozzles of all the same size greatly improves application uniformity and improves efficiency (more of the water is put to beneficial use).

In some cases, especially in alfalfa fields, under watering during certain times of the year was causing loss of yield. In some of those cases earlier irrigation start date was recommended to minimize the effect of shortages during the summer. Irrigating earlier in the spring when needed may cost more due to demand charges with the power company but it usually pays off in improved yield in the summer. In addition, groundwater levels and stream flows are generally high during early spring. In the majority of cases where under irrigation occurred, water supplies were inadequate to irrigate existing acreage adequately. In these cases the project encouraged more efficient water usage to get the maximum benefit from available water. In fields where over irrigation occurred growers were encouraged to irrigate less frequently or with less water per irrigation. Water savings were found primarily in fields of grass hay and pasture.

The survey pointed out the need to send the individual recommendations for system improvements to each of the participants. Some, who were unable to attend the dinner where the results were presented, have not seen their recommendations in writing although most were informed in the field by John Bennett of needed changes.

**Brochure on Techniques**

The funding also covered the creation of an informational brochure which has been produced at the end of the second instead of the first year, as had been proposed (See Appendix IV). The brochure will be used to publicize the benefits of this type of irrigation management. The University of California Extension paid a great amount of overrun costs incurred in the publication of this eight-page, color brochure. The impressive quality of the eight-page brochure will surely make up for the delay in publishing.

**Results**

Of the growers who completed the two seasons, only one was unable to continue using the sensors during the next season, and that was due to a personnel shortage, not a problem with the sensors. All cooperators were impressed with the knowledge that the evaluations and sensors provided and with the improved irrigation management that followed the changes they made.

The analysis showed who over-irrigated and who under-irrigated. Although the goal of this project is water conservation, the sensors also show when fields go too long without irrigation. Ranchers then need to irrigate on a more frequent basis.

During the two years, six ranchers consistently over-watered, while 13 normally under-watered. The graphs help visually show at what points of the year cooperators should be watering to achieve maximum efficiency for their crops, as well as for water conservation.

Although the project found that many of the cooperators were actually under-irrigating their crop, the evaluations conducted on their systems found numerous places where irrigation efficiency could be

improved. By repairing all measured leaks, among all of the cooperators, an estimated 171.8 gallons per minute could be saved. Switching all nozzles to single-matching heads would increase current uniformity by approximately 10% or more to nearly 80% for wheel line systems. The center pivot systems in the study had approximately 90% uniformity.

**Estimated Project Costs and In-kind Funds (See final invoice for detail, Appendix III)**
The UC Extension specialist and the technician implemented this project very expertly with little help from the RCD project coordinator, whose budgeted salary could then go to the technician. Although the project irrigation technician received more than the estimated amount, he also did much more than was originally expected of him. He knew all the ranchers and had their confidence to start with.

The project budget was able to cover the cost of additional soil moisture sensors for participants beyond the original number proposed. Nearly all participants have expanded the use of the soil moisture sensors to another field and, in some cases, to two more fields within the estimated budget of this project.

Matching funds from the UC Extension were beyond the estimated amount as the brochure costs were great and the amount of time the UC Extension specialist put into this project went beyond the estimated hours.

## Summary and Conclusions

In conclusion, all cooperators felt that this was a beneficial and informative program that will help them to become more efficient in their irrigation management, to increase yields, and to conserve water in the Scott Valley.

The benefits will be ongoing because the participating growers have learned very useful management techniques which they are enthusiastic about expanding; other growers will adopt the management techniques by word of mouth and from the brochure produced as a result of this project, and relationships between the growers and the UC Extension and the irrigation technician have been forged.

As most cases of over-watering have been found in the grass hay fields and pastures where much shallower root systems exist, we now know where the emphasis for future management should be concentrated for water conservation purposes.

**APPENDIX I**

## Participant Survey
## Irrigation Management Project
## UC California Extension/Siskiyou RCD
## 1999-2001

1. How would you rate the effectiveness (1-10) of this project as far as the improvement to your irrigation efficiency?
2. How would rate the effectiveness (1-10) of this project as far as its benefit to your crop yield?
3. Have you made all changes to your system (if any) recommended by Steve Orloff? Yes No
   Do you plan on it? Yes No
4. Are you planning on expanding this management technique by using water moisture sensors in other fields? Yes No
5. Are you one of the ranchers who requested more sensor equipment from the RCD?
6. Have you recommended this management technique to anyone else?
   Any further comments:

### Survey Results

| Name | Question #1 | 2 | 3a | 3b | 4 | 5 | 6 | Comments |
|---|---|---|---|---|---|---|---|---|
| Type of Answer | 1-10 | 1-10 | Yes/No | Yes/No | Yes/No | Yes/No | Yes/No | |
| Rick Barnes | 5 | 7 | yes | no | no | no | no | |
| Clint Custer | 7 | 7 | yes | yes | yes | yes | no | |
| Dick Dews | 8.5 | 8.5 | yes | no | yes | yes | No | |
| Skip/Tony Hanna | 8 | 8.5 | no rec | NA | yes | no | yes | |
| Dave Krell | 7 | 8 | no rec | yes | yes | yes | yes | Like to see contiinue |
| Sean Maloney, Tobias Ranch | 7 | 6 | yes | no | yes | yes | no | |
| Tom Menne* | | | | | | | | |
| Jack Pimentel* | | | | | | | | |
| Gareth Plank | 8 | ? | yes | yes | yes | yes | yes | |
| John Spencer | 7.5 | ? | yes | no | yes | no | yes | Saved water |
| Eric Black | 9 | 9 | no | yes | yes | yes | no | |
| Mike Bryan | 8 | 8 | yes | yes | yes | yes | yes | |
| Ron Yates, Dolcini Dairy | 7 | 7 | no rec | NA | yes | yes | no | |
| Warren Farnam | 7 | 7 | no rec | NA | yes | yes | yes | |
| Jason Finley | 8 | 8 | no rec | NA | yes | yes | no | |
| Dan and Rick Hayden | | | | | yes | yes | | |
| Charlie Martin | 9 | 9 | yes | yes | no | no | no | Good system and yie improvements |
| Clifford Munson | 7.5 | 5 | yes | no | yes | yes | yes | |
| Paul Sweezey | 7 | 7.5 | yes | no | yes | yes | no | |
| Kip Whipple* | | | | | | | | |

* Could not be reached in a timely manner.

**APPENDIX II**

## Water Conservation through Improved Irrigation Management Practices

Background for Growers Seminar 2-10-00

The work that John Bennett has been doing as a technical assistant to ranchers on irrigation management using soil moisture sensors is part of a two-year project funded by the Klamath Basin Fisheries Task Force. The project was developed by Steve Orloff of UC Extension and the Coordinator, Jeffy Marx, of the then Scott River Watershed CRMP Council, who wrote the proposal and who has been coordinating the project through the Siskiyou RCD.

The project is based on a study conducted over the previous three years by Steve Orloff, Farm Advisor with UC Cooperative Extension. Fifteen Scott Valley Growers participated in the study. The results indicated that there was potential to improve irrigation management in most fields. Improved irrigation management can conserve water and reduce power costs.

All interested landowners with alfalfa and/or irrigated pasture were eligible to participate in the project, including those who had participated in the previous study. Ten growers were selected for 1999 and an additional 10 will be selected in 2000. Priority is given to those who are willing to invest time to learn techniques and invest money for minor equipment improvements if warranted (e.g., new sprinkler nozzles). The project provides free resistance blocks (Watermark sensors) and a meter for each participating grower. The project also provides technical assistance to install the sensors, collect soil moisture measurements, evaluate the current irrigation system, and advise on when to irrigate.

The intent of the project is to conserve water and to maximize water use for the benefit of the grower and for the community at large, including wildlife.

The specific objectives of this project are as follows:

1. Evaluate the efficiency of existing irrigation systems/practices of 10 different growers per year.
2. Develop a theoretical optimum irrigation frequency using information on soil type, the irrigation system, and historical crop evapotranspiration data. To compare the theoretical irrigation frequency with current grower practices.
3. Identify areas where irrigation system improvements are warranted.
4. Use a "hands on" approach to inform growers when to irrigate specific fields and the correct amount of water to apply.
5. Train growers and Resource Conservation District employees on the use of soil moisture sensors and irrigation scheduling techniques to conserve irrigation water and optimize irrigation efficiency.
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7. Hold a workshop at the end of the two-year period for cooperators and project managers to share the results and the technology.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Water Conservation | |
| Darl Eastman | | | | | Through | |
| U.S. Fish & Wildlife Service | | Improved Irrigation management Practices | | | | |
| 1829 S. Oregon | | Agreement # 11333 9 JO48, Project # HR - 03 | | | | |
| Yreka, CA 96097 | | (RCD ref. # 49) | | | | |
| | | | | | | |
| | | | | | | |
| | | Remaining | Adjustment | Remaining | Final Invoice | Remaining |
| | | | | | | |
| a. Salaries ( including benefits) | | 1,951.65 | (72.35) | 1,879.30 | 1,879.30 | - |
| | | | | | | - |
| b. Travel and transportation (including per diem) | | - | | | | - |
| | | | | | | - |
| c. Expendable equipment, materials, supplies | | 2,982.20 | 80.36 | 3,062.56 | 3,062.56 | - |
| | | | | | | - |
| d. Operations and maintenance | | 2,500.00 | 108.88 | 2,608.88 | 2,608.88 | - |
| | | | | | | - |
| e. General and Administrative Expenses ( overhead) | | 304.82 | (116.89) | 187.93 | 187.93 | |
| | | | | | | - |
| Total Due | | 7,738.67 | - | 7,738.67 | 7,738.67 | - |

| | # 49 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | Item: | Salaries | Travel | Sub Total | Admin.10% | Exp. equip. | Op. & Maint. | Total |
| | | | | personnel only | | | | |
| | Budget | 18,730.80 | 2,080.00 | 20,810.80 | 2,081.20 | 15,940.00 | 3,964.00 | 42,796.00 |
| | | | | | | | | |
| | Total spent | 19,569.60 | 73.65 | 19,643.25 | 1,964.33 | 17,265.37 | 3,923.06 | 42,796.01 |

In kind $ 34,100.00